Challenges to Developing Interoperable Data Architecture to Support Sustainable Consumption and Sustainable Supply Chains

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Chapter 2
Challenges to Developing Interoperable Data Architecture to Support Sustainable Consumption and Sustainable Supply Chains

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Abstract

This chapter focus on the identification of key challenges to build a data architecture to improve sustainability in supply chains as well as providing consumers with better information for decision support. The chapter builds on the trends of sustainable consumption and sustainable supply chain management, and incorporates the views of key stakeholders in the coffee supply chain that we interviewed. Key challenges relate to accuracy and credibility of data in the system, to the availability of technical expertise and infrastructure across the supply chain, as well as with legal aspects related to data ownership, privacy and confidentiality. Finally, finding appropriate ways of funding the architecture constitutes another important challenge.

Keywords: Information asymmetry, Supply chain transparency, Sustainable consumption, Sustainable supply chains, Smart disclosure

2.1. Introduction

The issue of sustainable development is not new; the seemingly contradictory goals of economic development and environmental preservation have been encountered by mankind throughout its history. The well-known argument in *The Tragedy of the Commons* (Hardin, 1968) is based on a nearly 200 year-old observation of shepherds' treatment of common grazing pastures by an English economist, William Forster Lloyd. But the history of a concerted movement on the part of governments toward sustainable development and consumption is relatively recent, marking its

official start with the world-wide adoption of *Agenda 21* at the 1992 Earth Summit in Rio de Janeiro. The 178 governments that voted to adopt *Agenda 21* recognized the importance of sustainable development and committed themselves to the promotion of more sustainable consumption patterns.

The World Commission on Environment and Development (WCED) defines sustainability as "using resources to meet the need of the present without compromising the ability of future generations" (Lenton, Klassen, & Jayaraman, 2007). A mainstream approach to promoting sustainable consumption consists of government interventions to correct prices and provide regulatory frameworks to nudge producers into becoming more eco-efficient (Seyfang, 2005). Unfortunately, this approach has achieved only limited success, at least in part because of barriers to the dissemination of sufficient product information among all actors along the supply chain. In the vast majority of traditional supply chains consumers have only limited access to information about products' environmental and social impacts; and are thus forced to rely only on price and information printed on the product package to help them with their purchasing decision. This lack of information creates difficulties for consumers who are interested in assessing and understanding the implications of their consumption choices (Seyfang, 2005). But lack of integrated information about environmental impacts in the sustainable supply chain does not create problems only for the consumer, but rather has the potential to disrupt the entire system. Importers, for example, need assurance of their supplier's compliance with independent or voluntary codes of conduct or public standards (Vachon & Klassen, 2007). As we have seen in many recent examples, such as the Rana Plaza factory collapse[1], lack of knowledge about production practices or safety standards employed by overseas subsidiaries can have serious negative impacts on the reputation of major brands, subjecting them to economic and reputational losses.

As a result, governments begun to adopt a new approach to promoting sustainability that focuses on providing access to information to increase market transparency and efficiency, which in turn can lead to sustainable production and consumption. This new approach is based on the assumption that better informed consumers will make purchasing decisions that will provide

[1] http://www.theguardian.com/sustainable-business/2015/jun/10/rana-plaza-fund-reaches-target-compensate-victims

incentives for the whole supply chain to move toward a more sustainable production model. The smart disclosure initiative of the Obama administration is one example of such effort to promote innovations that help consumers use their social and environmental values to guide their marketplace decisions (Howard, 2012; Thaler & Sunstein, 2008).

The new approach partially stems from recent technological developments that have the potential to improve transparency of the supply chain processes by streamlining the information flow from the producer to a consumer. Such streamlined information flow could reduce information asymmetry in the supply chain (Jarman et al., 2011), which is generally characterized by consumers not having enough information to verify supplier/buyer behavior (Eisenhardt, 1989; Fama & Jensen, 1983); or by being unable to accurately evaluate information quality and breadth (coverage) (Akerlof, 1970; Mishra, Heide, & Cort, 1998). Reducing barriers to information flow would benefit not only consumers but also other actors in the supply chain, such as producers, retailers, distributors and certifiers. Well-known benefits include, for example, reductions on costs of coordination and increased flexibility (Malhotra, Gosain, & Sawy, 2005; Clemons & Row, 1993; E. Wang, Tai, & Wei, 2006). Less-studied potential benefits include the use of shared information to produce knowledge that can be used as marketing intelligence, allowing members of the supply chain to find new markets for their products (Malhotra et al., 2005). However, governance plays a key role in the distribution of benefits, which may in turn become one of the main barriers for sustainable coordination and information sharing (Clemons & Row, 1993; Johnston & Vitale, 1988).

As described in Chapter 1, the I-Choose project aimed at reducing information asymmetry by developing an interoperable data architecture that would support integration of information along the sustainable supply chain for coffee produced and consumed in the NAFTA region. We argue that by allowing for a more direct connection between the consumer and the producer, such data architecture would enable innovations and changes conducive to the development of a more sustainable production and consumption environment. This chapter focuses on the challenges to developing an interoperable data infrastructure for the sustainable coffee supply chain from the standpoint of key stakeholders as well as necessary conditions that would make such development possible. Both, the challenges and the system conditions were identified through our

workshops and interviews with various actors involved in the sustainable coffee supply chain.

This chapter is organized into five sections, including the foregoing introduction. Section two provides a literature review focused on the role of information in sustainable consumption, smart disclosure, and sustainable supply chain management. The third section outlines the key stakeholders of the sustainable coffee supply chain, their interconnectedness, and the flow of data that is relevant to assessing sustainable practices. The fourth section identifies challenges to developing an interoperable data architecture to share information from the perspectives of key stakeholders. The concluding section then focuses on the conditions and system requirements that are needed for development of integrated data architecture to be possible.

2.2. Literature Review

Over the last few decades the role of information in supporting sustainable consumption has been studied by various disciplines, each approaching the topic from a different standpoint. In the first part of this section we focus on reviewing literature that identifies information asymmetry as a major barrier to developing the necessary market conditions for further promotion of sustainable consumption, and the open data movement as an opportunity to address this problem. In the second part we review literature focusing on promotion of sustainability through a complete supply chain approach and how information integration across the supply chain could help decrease its information asymmetry (Seyfang, 2005).

2.2.1. Sustainable Consumption, Information Barriers, and Open Data

Although there is still no consensus on the exact definition of sustainable consumption (Mont & Plepys, 2008), the literature generally identifies two mainstream approaches to promoting sustainable consumption: 1) creating eco-efficiencies and "greening" the production processes; or 2) changing consumer consumption levels and patterns (Fuchs & Lorek, 2005; Mont & Plepys, 2008; Seyfang, 2005). Although the first approach, generally characterized by increasing production efficiencies and governmental regulations aimed at lowering environmental impact of production , has had a wide acceptance among governments, the second approach is regarded as having a potentially higher impact

due to the potential for lower consumption levels overall (Fuchs & Lorek, 2005). The second approach attempts to improve sustainability by setting up policies to influence consumers' consumption behavior (Seyfang, 2005) and relies on market forces and signals from consumers regarding consumption habits. In this way, increasing demand for "sustainable" products will eventually transform production practices and supply chain processes. This mainstream approach, highly dependent on consumer behavior, is thus prone to failure if barriers to information flow are present (Seyfang, 2005). Having all the necessary information, a consumer could scrutinize the supply chain, assessing how well practices and processes in it match her personal values to make a sustainable purchasing decision (Jarman et al., 2011). Unfortunately, in majority of supply chains consumers and other actors make decisions based upon limited information.

Of course the degree of information asymmetry depends on the type of product attributes one is searching for (Darby & Karni, 1973; Nelson, 1970). Nelson (1970) for instance distinguished between search and experience attributes. A search attribute (price, for example) can be known before the purchase, and consumers have the ability to search for it and can let it influence their purchasing decision. Experience attributes (flavor, for example) are only known after the consumer experiences the product (Nelson, 1970) and thus a consumer cannot use them to help him make the initial purchasing decision. However, even though experience attributes are not knowable prior to the purchasing decision, the consumer can use this information about his experience when making purchasing decisions in the future. Credence attributes (use of organic practices, for example), on the other hand, are not detectable to the consumer even after experiencing the product and he is thus forced to rely on third party judgment or certification (Darby & Karni, 1973).

The limited availability and unequal access to product information limits the ability of consumers to understand the environmental and social implications of their consumption decisions. In this way, eliminating or reducing information asymmetry is necessary for supporting sustainable consumption (Senge, 2008; Goleman, 2010). Efforts to reduce asymmetry of information related to environmental and social impacts have led to the proliferation of third party certifications and labels (Jahn, Schramm, & Spiller, 2005), which attempt to help consumers differentiate between organizations or products in respect to their

environmental and social practices. Unfortunately, these efforts are challenged by the ambiguity of what the various labels represent and the varied degrees of rigor behind each certification. Due to the diversity of certifications and labels, consumers might very well be wary of the meaning or credibility of information provided in the labeling scheme. Critical voices have also questioned whether the voluntary measures provided through labeling and limited product information were not a corporate "greenwash" or "bluewash" (Clapp, 1998; Fuchs & Lorek, 2005). Based on these limitations of third party certifications, Jahn et al. (2005) added a fourth dimension to product description, "Potemkin attributes". Potemkin attributes are visible only after a close examination of the internal processes used in producing and handling of a given product and are made available by tracing the provenance of information along the supply chain (Jahn et al., 2005).

The context described above constitutes an opportunity for open data efforts and for promoting innovation among a diverse set of individuals and organizations, including producers, supply chain operators, certifiers, government agencies, NGOs and information aggregators that provide analyzed information to consumers. Since 2009, US government and governments around the world have developed policy initiatives for promoting disclosure of information held by both public and private entities through open government and smart disclosure efforts. The goal of smart disclosure is to foster the creation of products and tools that help consumers make important marketplace decision. Although federal government has historically disclosed consumer information, the rise of Web 2.0 and Internet technology enabled governments to use information disclosure as a policy approach in areas such as health, education, energy, finance, and public safety. The highlighted benefits of smart disclosure include enabling consumer decision making in complex market conditions and improving economy by enhancing market transparency and efficiency. In order to achieve these benefits, it is recognized that disclosure of information held by public entities is not enough as vast amount of information that is relevant to consumer choices are held by private entities. To provide consumers with access to product information, companies involved in production and distribution of products need to be encouraged to release data that is of high quality and in machine readable format.

2.2.2. Information Technology and Sustainable Supply Chain Management

Wider interest in the issue of sustainability from the standpoint of industry begun with the recognition of companies as important stewards in addressing the challenges of sustainable development in the 1990's (Angell & Klassen, 1999; Matos & Hall, 2007). This recognition in turn created immense external pressure from government, the public and non-governmental organization forcing companies to integrate sustainability into their practices (Linton et al., 2007; Sarkis, Zhu, & Lai, 2011; Vachon & Klassen, 2007; Zhu & Sarkis, 2004).

The initial focus of companies was on integrating sustainability into their internal operations and reducing the adverse impact of their own organization (Hsu, Tan, Zailani, & Jayaraman, 2013). This strategy was soon deemed inadequate because of the interconnectedness of supply chain partners (Hsu et al., 2013). In reaction, companies started to explore management approaches that consider the environmental impact of the entire supply chain, from production, consumption and customer service to post-consumption (Hsu et al., 2013; Linton et al., 2007; Matos & Hall, 2007; Vachon & Klassen, 2007). Integrating sustainability management into the entire supply chain is considered to optimize the operation of the company (Linton et al., 2007) and minimize the risks of business operation and global competition (Beamon, 1999; Hsu et al., 2013).

However, in order to manage sustainability across the whole supply chain, it is necessary to share information about the sustainable practices and capabilities of all supply chain partners and to collaborate with each other to address various issues (Vachon & Klassen, 2007). This becomes especially important when consumer interest in company's sustainability practices are heightened, particularly in food and agriculture industry (Collins, Steg, & Koning, 2007; Locke, Kochan, Romis, & Qin, 2007; Locke & M. Romis, 2007; Opara, 2003; Wilson & Clarke, 1998). Thus information technology that enables information sharing and integration can play an important role in supporting sustainable supply chain as a whole.

This promise of information technologies, however, is yet to materialize, as information-driven supply systems and infrastructure are in the beginning stages of design and development (Steinfield, Markus, & Wigand, 2011). In practice, many barriers exist preventing full integration of information across the supply chain.

There is as much, if not more, incentive for hoarding or manipulating access to information, as there is for sharing information (Mishra et al., 1998). This opens the door to questions concerning stakeholders´ motivations to share information, distribution of benefits, and shifts of bargaining power in supply chains (Clemons & Row, 1993; Johnston & Vitale, 1988). Information systems that would dramatically reduce information asymmetries in supply chains would undoubtedly alter many important attributes of supply chains such as governance, incentives to share information and other resources, and motivations to create and participate in long term relationships.

In addition, supply chain actors must consider the cost and potential return as developing and maintaining sustainable supply chain management infrastructure will not be cost-free. Creating and sustaining sharing capabilities will impose additional costs on producers, retailers, and everyone in between. On the other hand, current IS research has shown that information sharing promotes efficiencies and cost reductions (Malhotra et al., 2005), and information sharing may create value through marketing intelligence (Malhotra et al., 2005). Yet, the positive impacts of such investments remain difficult to quantify and thus justify within the corporate structure (Wolf, 2011). Likewise, competition and market conditions make the distribution of such benefits inequitable and uncertain along the supply chain, further reducing possible incentive for information sharing (Clemons & Row, 1993; Han, Chang, & Hahn, 2011; Johnston & Vitale, 1988).

Summarizing the literature review on sustainable consumption and sustainable supply chain, it is reasonable to argue that developing information integration capability through an interoperable data architecture is a viable solution to some of the major roadblocks toward an expanded market for sustainable products. The development of such interoperable architecture, however, requires policy maker, managers, and developers to deal with a few key challenges facing the various players along the supply chain.

2.3. The Primary Data Producers and Information Flow in Sustainable Coffee Supply Chain

The coffee supply chain in the NAFTA region consists of multitude of actors with different roles and different responsibilities

in respect to data production, data maintenance and data ownership. Identification of these main actors is key to understanding the data environment in the supply chain and to identifying challenges to integrated information sharing. This section presents our findings about challenges faced by key stakeholders in the sustainable coffee supply chain based on data collected in workshops and 44 semi-structured interviews conducted throughout the I-Choose project, as well as an analysis of secondary data in the form of process documentation from seven major coffee certification initiatives: FLO, UTZ, 4C, RAN, C.A.F.E Practices, Organic, and Nespresso AAA (for details of methodology, see the Methodological Appendix of the book).

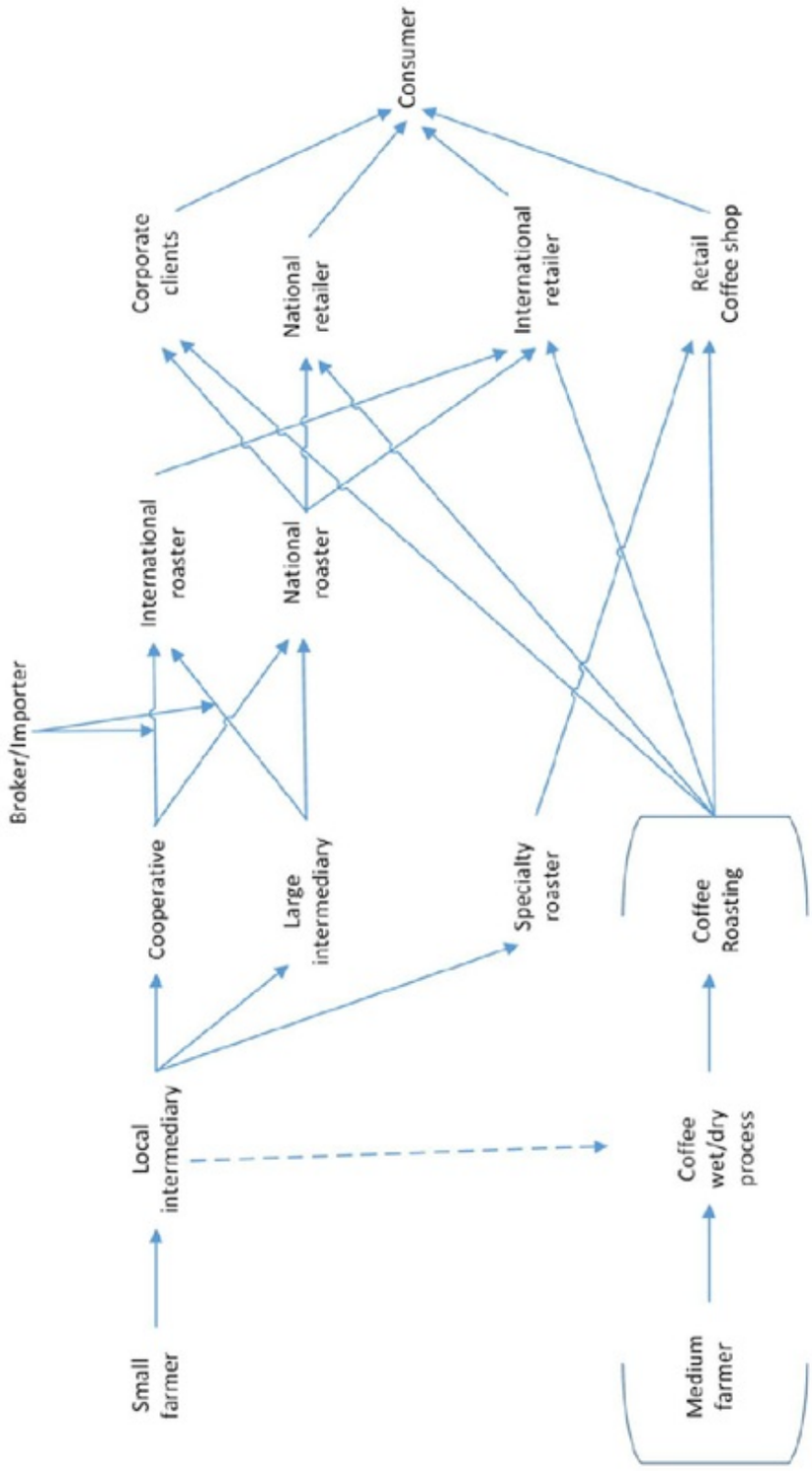
The workshop participants from the I-Choose project identified seven primary stakeholders in the sustainable coffee supply chain: consumers, producers, certifiers, retailers/roasters, distributors, cooperatives, and consumer associations (Sayogo et al., 2012). Individual interviews conducted as part of the I-Choose project with various stakeholders in the supply chain provided a more accurate account of the involvement of key stakeholders in the creation of data relevant to assessing sustainable practices, the direction of the data flow, and the challenges of data sharing and reuse.

In an ideal supply chain, the relationship between producers, retailers and consumers is rather linear in respect to product flow which is not necessarily accompanied by a related production information flow. In the case of a sustainable coffee supply chain, the actors and their relationships are more complex. In Figure 1 we depict several tiers of supply chain actors and the flow of product among them. This figure does not depict flow of information that accompanies products throughout the sustainable coffee supply chain; this flow of information is described in latter paragraphs in this section.

The sustainable coffee supply chain in Mexico includes two different kinds of coffee producers, small and medium farmers. There are no large farmers in Mexico because of land regulations that started after the Mexican revolution in the early 20th century. Medium farmers tend to integrate the value chain from production to roasting, and most of them have their own brands that are sold in national and international markets. Some medium farmers who are interested in exporting have some coffee certifications such as UTZ or the Rainforest Alliance. Small farmers, on the other hand, only

have access to the market through a local intermediary who may have access to larger intermediaries in the supply chain.

Figure 2.1. Main Stakeholders in Sustainable Certified Coffee Supply Chain



Larger intermediaries in the supply chain include cooperatives, specialty roasters and other larger entities, each of them buying product from different kinds of local intermediaries, and selling to a number of various types of clients. In the case of cooperatives, for example, local intermediaries are cooperative members at the local level. In the case of specialty roasters, the local intermediary is usually a well-known certified coffee taster who builds relationships with producers to improve their production methods, so they can provide the specialty roaster with high quality coffee to be sold directly to the end consumer in small coffee shops. Finally, other large intermediaries gather coffee to be sold to either national or international rosters and are usually in charge of the drying process, getting the coffee beans ready for roasting. Large intermediaries in the sustainable supply chain that we interviewed were certified by 4C, and belonged to the Nestlé supply chain.

The interview findings and secondary data analysis indicate that two major types of information flow along the supply chains: a) trading information and b) certification information.

In general, the information collection process for certification purposes begins when[2] an applicant submits an application package and documentation to a certification body. This package is evaluated to determine the eligibility and the scope of audit for the applicant, and if deemed eligible an authorized auditor conducts an audit on behalf of the certification body. The audit process involves several information collection processes: initial meeting, document review, interviews, physical site visit, and closing meeting. Following the audit, an audit report is sent to the certification body for further evaluation and subsequently for a certification decision. Even though the information is collected by a certification body, the ownership of all data collected during a certification process remains with the applicant, generally producers or roasters. The certification body acts only as an information custodian and stores the information in their database.

Information about products is also collected continuously during the trading process between producers and roasters/importers[3] through trading documents such as invoice, bills

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[2] Detail description of data collection process can be found in documentations published by third-party certification bodies. For example, for FLO refer to http://www.flocert.net/fairtrade-services/fairtrade-certification/how-it-works/

[3] Some roasters also act as retailers by directly selling their product to end consumers, some roasters sells their product to retailers and some roaster do both.

of lading or other documents, to ensure that the traded products are certified as sustainably produced. Each document for sustainable trading must be identified with particular certification body that the producers or roasters are registered with, usually in the form of a certification ID. In addition to the trading documents, some certification bodies require the roasters to submit quarterly reports of their sustainably certified coffee sales.

Given the complexities of the sustainable coffee supply chain and the number of stakeholders involved, it is not difficult to discern the difficulties of integrating information among these actors. In the next section we describe five categories of challenges identified during our project as they apply to three primary data producers in the supply chain – producers (small and medium farmers), roasters, and certifiers. More detailed descriptions of these challenges are provided in Sayogo (D. S. Sayogo, 2013; Djoko Sigit Sayogo et al., 2015; Djoko Sigit Sayogo, Zhang, Pardo, et al., 2014).

2.4. Challenges to Opening Data to Support Interoperable Data Platforms

The literature on information integration and challenges associated with such endeavors is numerous and spans a number of disciplines from science, to technology, business and medicine. Each information integration effort is unique, however, and as such entails unique challenges based on the complexity of the environment, the scope of the information landscape, the number of actors involved and many other factors. The sustainable coffee supply chain is no different, creating a set of unique challenges for the various stakeholders involved in data production along the chain. Throughout our interviews and workshops we have identified five main challenges to making coffee certification information more readily available to the public that producers, roasters and third party certifiers face as the primary data producers, data owners and/or data stewards.

2.4.1. Data Challenges: Collection, Accuracy, and Credibility

Interoperable data platforms, such as I-Choose, depend for its usefulness and accuracy of its recommendations on unfettered access to data from data producers and data stewards. The first step to making data from the coffee certification process available is to ensure that the necessary data is collected and is accurate and credible. Our interview findings indicate that the main data

producers and data stewards – coffee producers, roasters and third party certifiers - face a number of challenges when attempting to collect accurate and credible data.

Coffee producers. As we have seen in Figure 1 above, producer in a sustainable certified coffee supply chain is usually a cooperative comprised of a number of small farmers or a medium-sized plantation owner. Certification and inspection data for certified sustainable coffee consists of many pieces of data collected from small farmers by either their cooperative or a local intermediary. Farmers represent the smallest unit of data source and ensuring continuous flow of data from them is crucial for the certified coffee supply chain. Our interviews with various stakeholders indicated that requesting farmers to maintain consistent documentation of their production processes is the most difficult challenge. Typically, farmers do not understand the value of maintaining documentation, see documentation as a waste of their time, and are reluctant to record information about their products if the documentation process is complicated. As a consequence, cooperatives frequently have to assume additional costs to ensure data is collected. Cooperatives often distribute pre-defined and easy-to-fill forms to farmers or assign staff, usually the internal control, to solicit data from farmers through interviews.

Additionally, large intermediaries such as cooperatives or specialty roasters have to contend with ensuring accuracy and credibility of data in situations where small farmers, motivated by geographical location and financial issues, sell their coffee to local intermediaries who in turn sell it to the large intermediaries. Our interviewees stated that these local intermediaries, especially those who are not part of a cooperative, occasionally fabricate information about the certification of their product in order to quickly fulfill orders. Most often, these local intermediaries, record and report non-certified products as certified.

Roasters. Roasters' primary challenge is ensuring access to production data and credibility of the data they receive. Roasters generally procure their coffee from traders or importers. Our interviews indicated that some importers hesitate to reveal their information or source of information due to two reasons. First, some traders in a sense "cheapen[ing] the spirit of fair trading by manipulating prices during negotiations with producers. These traders thus do not wish to disclose their source of product and producer information. Second, hoarding or hiding information is seen by some traders as a competitive advantage and strategy to

mitigate threat of substitution. As a result, roasters are often faced with incomplete and inaccurate data regarding the origin of the product they purchase, which in turn affects their ability to provide accurate and complete data for their roasted product.

Third party certifiers. Third party certifiers face similar challenges as those faced by data producers. Our interviewee from Control Union, a globally recognized certification agency, indicated that inspectors who conduct audits in the field often encounter incomplete or unavailable information for their audit. Since audits are conducted only once a year, the information gaps hinder the ability of inspectors to understand what happens in the period between audits. In addition, despite the existence of criteria that are in turn governed by standards, inspectors and evaluators still need to exercise their own judgment when applying the criteria in the field. For example, the third level indicators for criteria 3.2.22 of Fairtrade (FLO) – training members on appropriate use of fertilizers – are: a) at least 50% members have been trained, and b) content of training was sufficient. The inspectors need to use their judgment based on their expertise and experience to measure the sufficiency of the training content. When consistent and reliable information is lacking, the audit reports that are at the core of certification and inspection data are prone to human judgment biases. Without adequate information, auditors must use their experience in deciding the extent to which the applicant conforms to the given criteria and standard.

2.4.2. Technology Capability: Technical Expertise, Hardware and Communication

The second large challenge facing producers, roasters and third-party certification bodies is limited technological capabilities including limited technical expertise of people on the ground, limited access to technology (hardware), and lack of access to reliable communication infrastructure.

Coffee producers. Limited access to technology and limited technical knowledge represents a major challenge for both kinds of coffee producers – small farmers and local cooperatives. Lack of technical expertise and access to technology is especially severe at the small farmer level. Our interviews with small farmers point to the challenge of accessing technology due to the geographical remoteness of their location. For instance, when trying to sell organic coffee such as US Department of Agriculture (USDA) organic, small farmers have difficulties with publishing their

organic certificate, which requires information technology as well as a reliable internet connection to access the certifier information system. Both tend to be in short supply in some of the remote areas of Mexican coffee producing states.

Limited access to technology at points of production also represents a challenge for local cooperatives that are forced to assign additional staff in locations where technology is accessible to facilitate communication with traders (roasters and importers). An additional challenge facing local cooperatives is acquiring the necessary technical knowledge that would be required to manage an implementation of system that would allow them to digitally integrate data from individual small farmers were they to adopt computerized record keeping.

Roasters and Third Party Certifiers. Interviewees from roasters and third-party certifications asserted that they are sometimes limited by their lack of technical expertise despite their willingness to disclose their data. For instance, our roasters/importers interviewees abandoned their efforts to publish coffee contract documents online due to the lack of sufficient technical expertise that would be needed to build a robustly protected and highly functional database system. Our interviewee from Fair for Life also stated that their organization limits the publication of certification ratings and indicators on their website due to technological capability concerns. The interviewee indicated that they have to use the help from external programmers, which is an additional cost. While larger organizations such as FLO might have the resources to build and maintain a system that allows public to access information about certification, smaller certification systems with smaller target markets simply do not possess the financial resources needed. Although large organizations like FLO do make their systems available to other participants in the system, the licensing costs are high for small and medium roasters and third party certifiers. The diversity of systems developed by small and medium roasters, besides their technical limitations, poses the additional challenge of integration of information.

2.4.3. Challenges to Third Party Certifier: Data Ownership and Conflict of Disclosure Policy

Majority of data related to product inspection and certification as well as to sustainable trading is in the stewardship of third-party certification bodies that collect and store such data. Opening the data available in third party certification databases

could provide substantial benefits for promoting sustainable consumption practices by lowering information asymmetry in the supply chain through innovative technology solutions that would make such information accessible in an easily understood format. However, third party certifiers face two interrelated challenges to publishing their data: data ownership and conflict with applicant's disclosure policy.

Data ownership. Even though third-party certification bodies are responsible for collection and maintenance of certification data, the data ownership remains with the applicant, usually the producer or roaster, not the certification body itself. Thus any release, access to or publishing of this data requires consent from the applicants, which is often difficult to obtain, not only because producers need to be willing to disclose their information, but also because producers –as we described before—are usually large cooperatives or federations of cooperatives with thousands of members. In such situations, reaching to an agreement to disclose data is a very challenging task. Moreover, most certifications are designed with the assumption of data confidentiality as part of their core strategy to attract new producers. Even those that promote a more open system face this challenge in a regular basis. Interviewees from Fair for Life certification –a certification system with an open policy—indicated that the option for data owners to publish certification results is voluntary, and applicants can opt out from this requirement. Consequently, certifiers are limited in the amount of data they can publish.

Conflict of Disclosure Policy. As we briefly commented in the previous paragraph, the disclosure policy of the certification body often conflicts with the disclosure policy of the applicant with regard to publishing certification data. According to an interviewee from CERTIMEX, one of the first things that auditors do when they start working with an applicant is to sign a legally binding document that acknowledges that the ownership of all certification-related data remains with the applicant. Applicants, in the meantime have their own information policies governing the release of their data, which generally operate on full consensus of all cooperative members. Given the number of farmers and their limited incentive for releasing such data, acquiring a permission for release is quite difficult and time consuming. Other type of applicants, such as medium farmers, take into consideration their own disclosure policy before deciding whether to publish their certification data; and they

are especially concerned about the impact to their brand and reputation.

2.4.4. Information Policy: Confidentiality, Commercial Privacy and Economic Value of Information

While disclosure of information has the potential to greatly benefit the public as well as the entity disclosing such information, disclosure also carries risks associated with safeguarding information that might hurt the organization both in the short and in the long term. Our interviews indicate that many companies lack policies that would clearly identify which and how much information should and should not be disclosed due to concerns related to privacy, confidentiality and economic competitiveness. Interviewees from mission-driven companies pointed out that a major barrier to opening their data is making a decision about how to balance disclosing enough information to create value with disclosing information without violating disclosure restrictions. Interviewees from corporate entities within the supply chain showed willingness to open their data if doing so adds value to the organization and restrictions related to the confidentiality and economic value of information can be implemented easily. Some information is closely related to competitive advantage and disclosing it potentially endangers the organization's market share.

There is also the issue of ensuring commercial privacy. As alluded to in the paragraph above, disclosing certification results might compromise the reputation and competitive advantage of the applicants. The problem is not necessarily new because supply chains have already a long tradition of sharing information to reduce costs and improve flexibility (Malhotra, Clemons). However, it has also been identified in the literature that the distribution of both costs and benefits can be one of the main barriers to continued information disclosure inside the supply chain. The issue becomes more salient when considering not only these private exchanges, but also public disclosure of information.

2.4.5. Financial Costs of Digital Data/Information Disclosure

As discussed above, the costs and challenges associated with information collection are tremendous. But the costs associated with information disclosure are not limited just to the point of collection, but also involve costs associated with disclosing such information in a digital, machine readable format, as well as the continuous process of updating and maintaining the shared resource. Such

information disclosure can be very costly to all actors involved with data production and maintenance.

The interviewees indicate that indirect costs of certification can be very expensive even if mechanisms exist to mitigate direct costs. For instance, third-party certification generally requires producers to maintain records and documentation to support the certification and/or traceability efforts. Maintaining records and documentation represents a major cost for producers due to the challenges discussed in sections above. Publishing their data online is costly for both roasters and third-party certification bodies as well. For roasters, additional work is required to transfer information from an offline format to online or to public domain, which increases expenses. For third-party certification bodies, the information can be extensive; for example, audit results might consist of 30 pages with 10 or 20 control points for each category, making open data costly for them.

As the foregoing discussion indicates, the challenges to creating an interoperable data sharing platform are numerous. As with any information sharing effort, it is not just technical limitations that might make development of such platform difficult, but also issues connected to policy and governance issues, data reliability and trustworthiness, and creation of economic incentives for various actors along the supply chain. In the concluding section of this chapter we discuss some of the practical implications of these challenges in regards to creating conditions that would allow for successful integrated data sharing along the supply chain for sustainable coffee.

2.5. Conditions for Developing Interoperable Data Platform in Sustainable Supply Chain

An interoperable data platform does not consist just of the software, hardware and data contained in it. Rather it is a system enveloping components of governance, policy, business, trustworthiness, stakeholder relations and more. The following paragraphs begin to sketch a few system components and conditions that are necessary for a good foundation of interoperable data platform.

2.5.1. Ensuring Information Integrity, Trustworthiness and Security

The functionality and usefulness of any information sharing system depends on the degree to which information contained in the system is accurate, timely, and useful, and the extent to which it protects integrity of the said information. In other words, assuring data's trustworthiness is crucial when data is being shared among various sources and in various formats, and also in creating aggregated information from the shared data (Dinh, Wenqiang, & Datta, 2012). The degree of trust toward the data and the platform's security presumably influences the likelihood that both consumers and supply chain partners will use the information produced by a system like I-Choose and thus creating technical and process mechanisms to ensure information integrity is essential.

Information security in platforms such as I-Choose is particularly important because data that is relevant might often be considered confidential and/or proprietary. As noted in previous sections, our interviewees considered some of the information disclosed during a certification process as vital to their economic competitiveness. As a result, any information architecture or platform would need to incorporate proper access controls to authenticate its diverse users to ensure that proprietary data is not being accessed inappropriately. To ensure participation of some of the key actors of the supply chain, the developers must find an effective ways to involve primary stakeholders, if not primary data producers, in designing the information security requirements from the start. Such participation will boost stakeholders' trust in the data and enhance confidence among data owners that their proprietary data is well protected (see chapter 6 for a discussion on security and privacy requirements and challenges).

In addition to data security, developers also need to ensure trustworthiness of data in their system. Recent research examined trustworthiness of data through various lenses, namely, data integrity, data quality, and data lineage and provenance (E. Bertino & Lim, 2011; Elisa Bertino, Dai, & Kantarcioglu, 2009). Previous research on data quality suggests that, from the user perspective, data quality correlates to high relevance (Elisa Bertino et al., 2009; Tayi & Ballou, 1998; R. Y. Wang & Strong, 1996). In terms of data provenance, trustworthiness of the data is defined as having access to the source and origins of the data (E. Bertino & Lim, 2011; Elisa Bertino et al., 2009; Ram & Liu, 2009).

Few researchers, however, pay attention to the role that can be played by governments. Presumably, government policy promoting information disclosure held not only by public entities, but also private entities contributes to market transparency and trust production in sustainable markets. Trust is often related to institutional factors, such as legal contracts, social networks, and societal norms that make opportunistic behaviors less likely. Arguably, government efforts in establishing legal framework to ensure consistent product standards for sustainable products could contribute to the development of consumer trust. Using a survey, we investigated the determinants of consumer trust in the presumed sustainability of a product (Djoko Sigit Sayogo, Zhang, Liu, Picazo-Vela, & Luna-Reyes, 2014). Our results suggest that in the case of sustainable products, brands, certificate's reputation, support from government agencies and endorsement from non-for-profit organizations significantly influence consumers' trust in the product. We argue that to be useful, additional information from the certification process should be aggregated and presented to consumers in a simple and value added fashion.

Nonetheless, our research is only the first step to understanding the dynamic interaction of market and government policy. The issues of generating and measuring data trustworthiness from the user perspective are still very much open for thorough investigation. The challenge of creating trustworthiness in the system is discussed in more detail in Chapter 3.

2.5.2. Creation of Semantic Compatibilities among Standards and Protocols

Although the interviewees did not explicitly emphasize the issue of semantic incompatibilities, this issue is crucial for developing platform such as I-Choose. There are diverse certification standards and protocols applied to the sustainable certified coffee supply chain (van Hoek, Vos, & Commandeur, 1999; R. Y. Wang & Strong, 1996) and each uses different criteria and processes for assessment and certification. The EcoLabelIndex[4], an information aggregator on eco-certifications, is currently tracking 444 ecolabels in 197 countries, and 25 industry sectors. Consequently, to provide trustworthy recommendations, platforms such as I-Choose need to take into account these diversities by creating semantic compatibilities among standards and protocols. Technically, the development of semantic

[4] http://www.ecolabelindex.com

compatibilities and common language and schema among diverse knowledge is possible through ontology to facilitate automatic data extraction and reasoning about sustainable certification and trading. The primary stakeholders in sustainable certified coffee supply chain could share a common understanding of the certification structures through the ontology layers. Chapter 5 in this book includes a more detailed description of our project's efforts toward developing an ontology that would accommodate data from sustainable coffee supply chain.

2.5.3. Designing Information Policy That Balances Commercial Interests and Openness

One of the biggest challenges facing a system such as I-Choose is the lack of economic motivations for information disclosure. The interviewees indicated inclination and willingness to open their information only if doing so adds value to their organizations. Thus, it is important to design information policy that balances the desire for supply chain transparency and the need for keeping businesses competitive. A lesson from studies in economics can be used as a starting lens. These studies point out that timing and manner of disclosure supersede the decision of whether companies need to disclose. Appropriate timing and method for information disclosure can mitigate the company's fears that disclosure will disrupt their market position and thus allow them to accrue the benefits from disclosing information (Vachon & Klassen, 2007).

2.5.4. Creation of business model for integrated data platform

The potential for a business or revenue model of systems like I-Choose has both practical and research implications. Arguably, the existence of an integrated and open data architecture might provide fertile ground for entrepreneur development. Processing and providing users' information that fits their needs could create innovative business models based on market signals and value provisions.

Our current simulation experiments reveal that the market resists "take-off" unless external financial support can be found (Ran et al., 2016). Additionally, "take-off" dynamics of the system are dominated by marketing budgets and external support for infrastructure. Marketing budgets drive how fast users adopt the system, and without external sponsorship of system, the final market collapses. Further research investigating an appropriate business

model would be beneficial for the development and adoption of such innovation as I-Choose.

2.5.5. Establishing Collaborative Governance Model

A number of the challenges discussed above call for attention to policy development in respect to governance. Specifically, interoperable systems that integrate various organizations in the fragmented supply chain and multiple certifications would involve multiple stakeholders with diverse interests, degrees of power and values. Integration of these diverse values necessitates the construction of governing mechanisms that take these complexities into account.

One possible governance intervention is the creation of data commons governed by collaborative governance body (Flynn, Huo, & Zhao, 2010). This is a roundtable type of governance model involving stakeholders in the supply chain. The function of such governance mechanism is to generate policies to support the implementation of platform such as I-Choose. This governance body supervises the creation of semantic compatibilities among standards and protocols, the creation of information security policies, and the design of information policy that balances the need for commercial privacy and desire for information openness. Jarman et al (2011) envisioned balancing three elements of 1) "hard" regulation, 2) partnership building, and 3) wider participation from consumer review as one plausible governing mechanism for I-Choose. Chapter 8 of this book further discusses governance issues and further paths for development.

The involvement of various supply chain stakeholders including government regulators, industry associations, consumers, consumer advocates, producers and others is a must. Involvement of these stakeholders in the governance body minimizes resistance caused by variety of conflicting interests as well as making sure that all stakeholders' interests are represented. This way the issue of negative impacts to sustainability and competitiveness can be mitigated, especially for stakeholders with less power and influence.

2.6. Concluding Remarks

Information asymmetry in the relationship between end-consumers and firms in supply chain is argued to be one of the key barriers that confines the proliferation of sustainable consumption (Seyfang, 2005). A challenge to remedy such problems lies in

making vast amounts of disparate data and information regarding sustainability practices shareable across the supply chain and usable by end-consumers. One key missing element is a platform that combines interoperable data standards and architecture with policy and governance mechanisms. This paper presents main issues and key requirements to be considered in developing data standards to support interoperable platform for sustainability as perceived by key stakeholders in sustainably certified coffee industry. Subsequent analysis of the issues and challenges then enable us to identify the key requirements to be considered for developing such platform and future research directions.

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